Space Weather Technical Forecast

Issued on Friday, 25 November 2022 at 12:36 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Peak Chance of Minor Geomagnetic Storm (G1) intervals on Saturday (UTC).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low in the past 24 hours, with X-ray activity at GOES16 showing isolated C-class activity on a background of mid-B-class. The largest flare of the period was a C1.1 at 25/0722UTC, emanating from AR3149 in the northwest. This was one of four numbered sunspot regions on the disc, all simple and stable or in decay with the exception of a growing and proliferating small Bxi/Beta group in the northeast: AR3152.

The main potential Coronal Mass Ejction (CME)-generating event of the period was a large but slow potential sequential filament lift-off from the south central disc around 24/1200UTC and again between 24/1800-2100UTC. There are some early signs of ejecta leaving the Sun directed mostly to the south of the ecliptic plane, however this will be confirmed as more imagery becomes available. At present then, there are no new Earth-directed CMEs observed in available imagery.

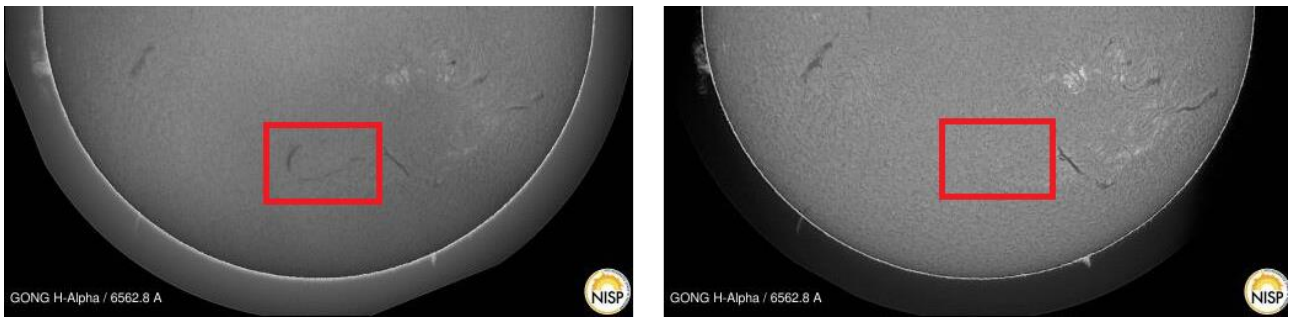

Figure 0: NSO GONG H-Alpha imagery from El Teide observatory at 24/1300UTC left, and Cerro Tololo (right), immediately preceding and following the possible staged filament lift-off from the south centre disc. While there is some ejecta visible on coronagraphs which appears directed mostly south of the Sun-Earth line, proper analysis will be conducted when further imagery becomes available.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by ACE and DSCOVR at L1 showed a transition from a slow regime into a high speed stream, perhaps that from CH47/+, else CH48/+, with some extreme UV (e.g. AIA211) imagery tenuously linking the two. The phi angle was accordingly mostly positive (away from the Sun) following connection to the coronal hole proper after 25/0220UTC, else being more variable in the preceding slow wind, and then CIR-like environment (Co-rotating Interaction Region).

The solar wind speed rose from Background levels near 300km/s to become Slightly Elevated to end Thursday 24 November, with a step-wise increase to around 475km/s observed after 25/0220UTC, with an absolute peak near 500. The solar wind density showed a rising and then falling tendency by comparison as the CIR came and went, rising from 10 to 45ppcc in the UTC

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evening before moderating back to near 10ppcc as the UTC day of Friday evolved. The corresponding IMF rose from a flat trend near 3nT to peak at 16nT after the change. The north-south component was more erratic, being mainly co-aligned with Earth's field prior to 25/0100UTC, but switching to become more anti-aligned thereafter, with a range of +/-13nT.

The net result of the above solar wind measures was an increase from provisionally Quiet to Unsettled geomagnetic activity, with a peak of Kp 3+ seen at 06-09UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES16 has remained at Background levels.

High energy electron flux (greater than 2MeV) at GOES16 was at Normal Background levels. Electron fluence levels remained well below Active (1e8 integrated pfu) levels. Observed fluence at 25/0001UTC was 1.33e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to remain Low or Very Low, with a Chance of isolated C-class flares and a Slight Chance of isolated M-class X-ray flares. To end the four-day forecast period, new regions may rotate onto the visible disc, although these are not expected to be significant.

Solar Wind / Geomagnetic Activity: Several recent CMEs occurred on or close to the Earth-Sun line which could give glancing blows on passage. The CME from the C7 flare at 22/0727UTC and a CME from the C4 flare of AR3151 at 22/1900UTC are both likely to pass beneath Earth's orbit but may produce minor peripheral impacts on Saturday 26 November.

Continuing Slightly Elevated solar winds are expected from presumed current CH47/+, with a chance of temporary Elevated solar wind speeds developing. Further enhancements in the solar wind are possible through the rest of the forecast period, from either the weak passing CMEs on Saturday 26 November, or from a new connection to CH48/+.

There is a Chance of Active Kp intervals on the first three days of the forecast period, respectively from CH47/+ to end the current UTC working week, and then lower confidence events from Saturday 26 November: up to two glancing CMEs and perhaps a resurgent fast wind from CH48, although the former may miss and any increase from the latter may be indistinct from the current CH47 fast wind.

The most reliably Quiet conditions of the period are Expected on day four, Monday 28 November. The peak risk of Minor Storm G1 should occur on Saturday 26 November, perhaps a Chance.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) observed by GOES16 is expected to remain at Background levels throughout.

The high energy Electron flux (greater than 2MeV) at GEO is forecast to gradually react to the incumbent fast wind in the period, although the magnitude to which this adjusts is low confidence. The associated 24-hour integrated fluence is Expected to remain below Active (1e8 integrated pfu) at first, however confidence in this persisting falls with time, especially from later in the UTC weekend - with a rising trend expected.

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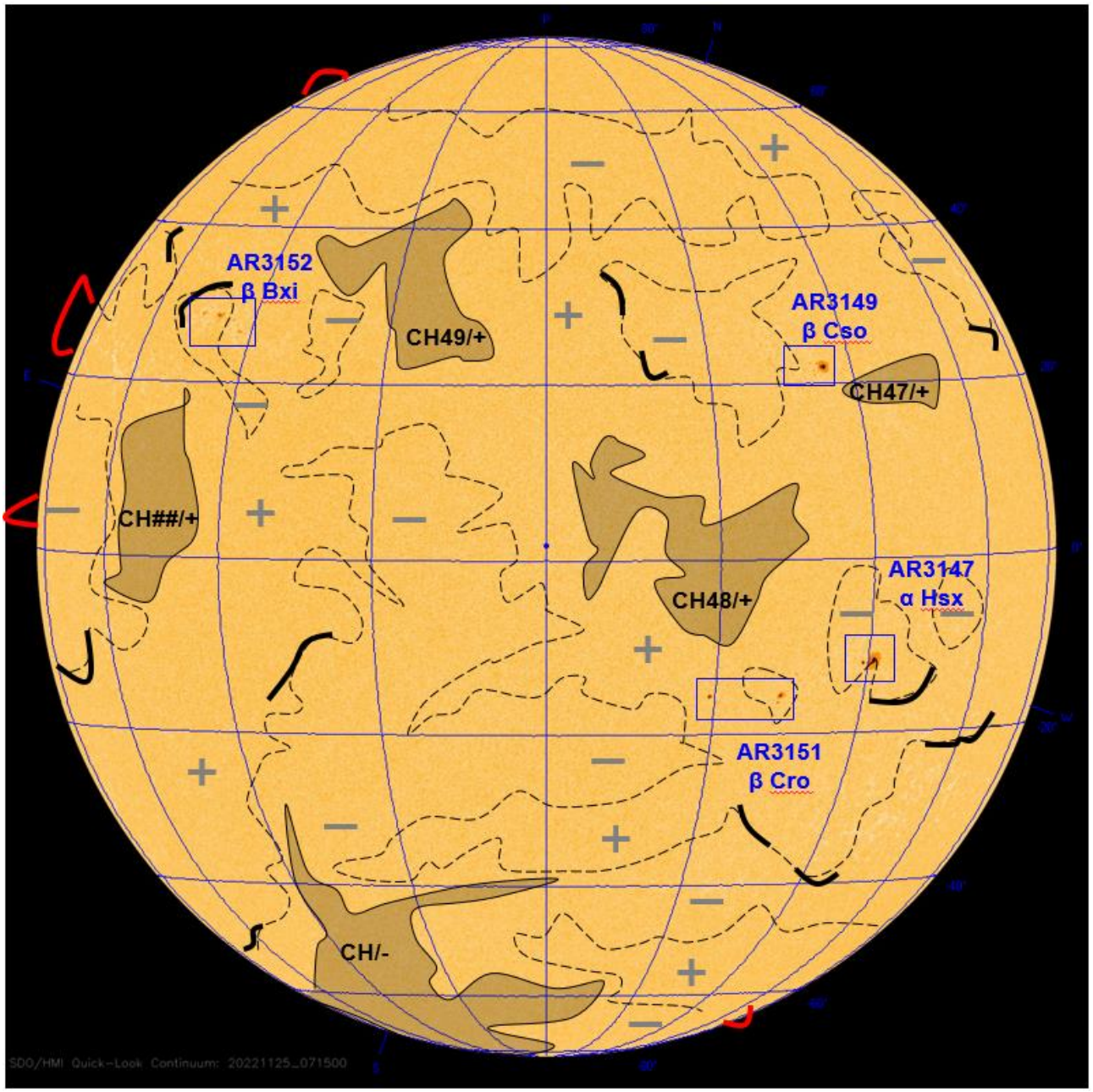
Figure 1. Solar Analysis Valid 25/0715UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Several recent CMEs occurred on or close to the Earth-Sun line. While these may have partially Earth-directed components, they are likely to only give minor effects should they occur (perhaps solar wind density increases from passing shock side-lobes). The CME from the C7 flare at 22/0727UTC and a CME from the C4 flare of AR3151 at 22/1900UTC are both likely to pass beneath Earth's orbit but may give a glancing blow with minor peripheral impacts on Saturday 26 November. In addition to the above, the 24/1800-2100UTC filament eruption has yet to be unassessed, pending imagery.

The geomagnetic forecast otherwise comprises a possible step-wise descent into a pair of coronal hole fast wind streams - the first is now in course and probably emanated from CH47/+, and the second may take the form of a magnitude increase on day two, Saturday 26 November. Because these events carry the same polarity and appear tenuously connected in some EUV imagery, any transition may be indistinct, and they may form a more continuous fast wind near current peak speeds of 500km/s.

The geomagnetic forecast should see Likely Active intervals on the first three days of the period, with the passage of the threat of the pair of CMEs and the maturing coronal hole fast winds meaning that the start of the new working week should be the most reliably Quiet day of the forecast. The peak risk of a Chance of G1 should occur on Saturday 26 November, with the CMEs possibly coinciding with CH48's fast wind.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	30	20	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
23/0310	Partial	C4 AR3151	SE quadrant	500	Late UTC day 26 Nov	Glancing blow, low confidence
22/1925	Partial	C7 AR3151	SE quadrant	405	Early UTC day 26 Nov	Glancing blow, low confidence

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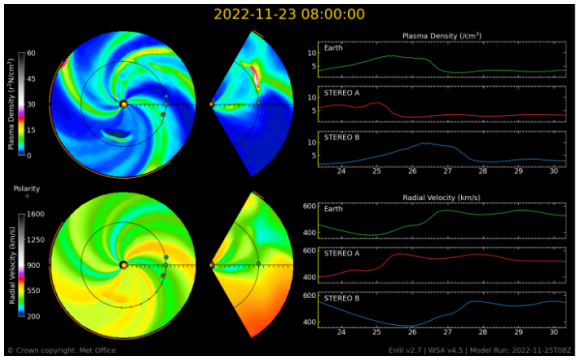
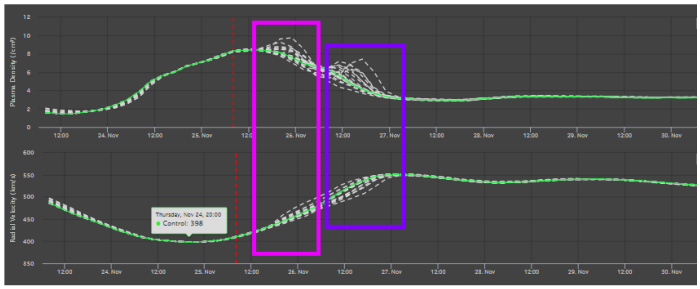
Figure 2: Latest MOSWOC Enlil run, showing up to two possible minor glancing blows due inside 24 hours from either of a pair of C-class flare-related CMEs that left the Sun on 22 November. The magnitude of the modelled fast wind that Earth is currently transiting is perhaps slightly underdone, which may mean that any CMEs effects arrive on the earlier end of the suggested range (if present). Note that the filament eruption(s) of 24 November do not yet feature in modelling.





Radio Blackouts - X-Ray Flares:

Solar activity is forecast to remain Low or Very Low over the four-day period.

All of the current Earth-facing sunspots are small and simple, as well as being either stable or in decay. The sole exception to this trend is AR3152 in the northeast, however although this group is both proliferating in terms of constituent spots and growing areally, it has thus far only peaked at a Bxi/Beta with no significant flares.

Regarding the balance of front-sided sunspot regions in the period, there are up to two regions leaving into the new UTC working week (AR3147 and AR3149). Meanwhile, on the eastern horizon, the Carrington locations for several far side regions should arrive, resulting in an overall level trend in the four days as none of the upcoming sunspot groups has shown inferred significant flare or CME activity from coronagraphs.

All in, C-class flares are rated at a Chance throughout, while M-class have been revised downward slightly to a daily Slight Chance given the dearth of even C-class activity in recent hours and the front-side's overall decaying trend.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	5	5	5	5
Very Active	R3 to R5 X Class	No	1	1	1	1

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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) at GEO, as observed by GOES16 is currently at background levels and is expected to remain at this level throughout.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2 MeV) observed by GOES16 has been at Normal Background in recent days. The effects of the incumbent fast wind on electron populations at GEO should start to be seen into the coming UTC weekend, with the current flux perhaps reaching diurnally High levels in the succession of CH47 and then CH48, although this depends on intervening CME activity and the magnitude of these high speed streams.

The quieter conditions that should greet the forthcoming new UTC working week should allow the Van Allen belts to equilibrate, and ought to offer the highest likelihood of exceeding Active 24-hour integrated fluence. Because this occurred on last rotation this is considered 'odds on', however there are added CME complications on this occasion that render the uncertainties a little higher.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	10	20	60
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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